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Science Advisory Report 2016/056

EVALUATION OF HABITAT RESTORATION ACTIVITIES FOR SPECIES AT RISK FISHES WITHIN CROWN MARSH (LONG POINT BAY)

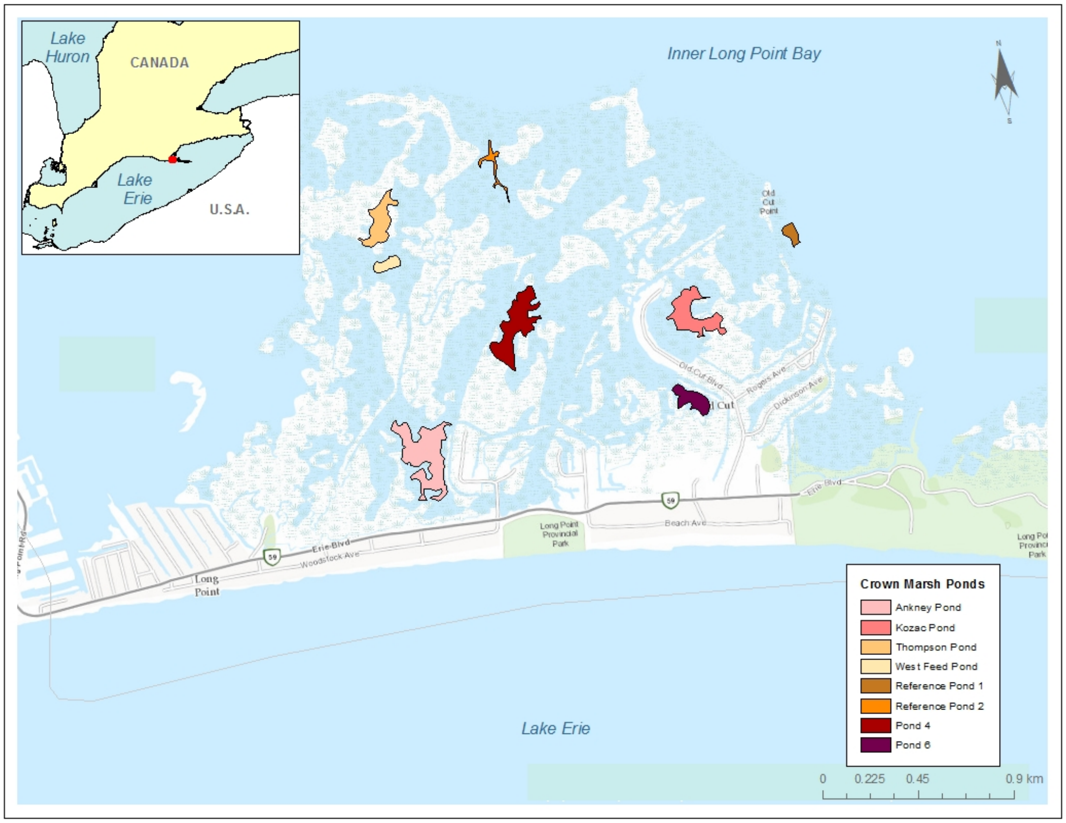

Figure 1. Locations of the constructed and natural ponds in Crown Marsh, Lake Erie, Ontario. Reference Pond 1 and Reference Pond 2 are natural ponds, all others are constructed ponds.

Context:

*Dredging has occurred in Long Point Crown Marsh to remove the invasive common reed (*Phragmites australis*). Crown Marsh is home to at least 34 fish species, five of which are species at risk. There are concerns that the creation of open-water ponds may negatively impact the species listed under the federal* Species at Risk Act *(SARA), and may function as ecological traps. Currently, it is unknown how species at risk respond to the creation of ponds in Crown Marsh.*

Fisheries and Oceans Canada (DFO) and the Ontario Ministry of Natural Resources and Forestry (MNRF) undertook a 3-year monitoring program in Crown Marsh. The goal of the monitoring program was to compare and characterize the fish assemblages and habitat conditions in the constructed sites to reference sites. This was in addition to assessing the value of the habitats for species at risk and determining approaches to maximize the value of the ponds to species at risk.

This Science Advisory Report is from the May 4, 2016 regional peer review of the Evaluation of habitat restoration activities for Species at Risk fishes within the Crown Marsh (Long Point Bay). Additional publications from this meeting will be posted on the DFO Science Advisory Schedule *as they become available.*

SUMMARY

- Crown Marsh is a freshwater coastal wetland located in Long Point Bay, Lake Erie. It has been invaded by common reed (*Phragmites australis*), an invasive perennial reed species, which has led to reductions in native wetland plants and open-water habitat and has indirectly impacted taxa dependent upon these habitat features, such as fishes.
- To rehabilitate Crown Marsh, common reed was mechanically removed to create open-water ponds. However, the extent to which the constructed ponds act as ecological traps (i.e., preferred areas that have disproportionally high natural mortality or reduced fitness), with negative effects on fishes currently listed under the federal *Species at Risk Act* (SARA), was unknown.
- Fisheries and Oceans Canada (DFO) and the Ontario Ministry of Natural Resources and Forestry (MNRF) undertook a 3-year monitoring study to determine fish use and habitat quality of the constructed ponds.
- The constructed ponds were utilized by species at risk such as Grass Pickerel (*Esox americanus vermiculatus*), Lake Chubsucker (*Erimyzon sucetta*), Pugnose Shiner (*Notropis anogenus*), and Warmouth (*Lepomis gulosus*). These were found at low abundances in the newly constructed ponds. Inner Long Point Bay is listed as critical habitat for Eastern Sand Darter (*Ammocrypta pellucida*) and Spotted Gar (*Lepisosteus oculatus*), but these species were not captured in any pond throughout the study.
- The constructed ponds had no significant difference in species richness compared to reference ponds. There were significant differences in community composition between constructed and reference ponds. Reference ponds had a more stable fish community among years sampled.
- Based on the wetland fish index (WFI) assessment, where a score less than 3.25 indicates a degraded wetland, and a score greater than 3.25 indicates a healthy wetland, all of the constructed and reference ponds achieved a score greater than 3.25 indicating good wetland health.
- All of the ponds sampled had a connecting channel to Long Point Bay. Water remained in the channels throughout the year, providing fishes with access in and out of the ponds.
- The constructed ponds acted as nursery habitat for fishes. Twenty three young-of-year (YOY) and juvenile fishes were detected in the newly constructed ponds, including the four species at risk.
- Newly constructed ponds were shallower than the reference sites. Due to the observed high water temperatures in the summer, low dissolved oxygen concentrations, and the possibility of complete freezing in the winter, it is suggested that to satisfy restoration objectives from an at-risk fish perspective, the ponds should be constructed with a gradient with the greatest depth at the mouth of the connecting channel so fishes can exit the ponds during low water periods.

- It is recommended that a permanent channel be maintained for each pond to ensure fishes are able to enter and exit the ponds as needed based on seasonal influences. This will help promote the survival of fishes and prevent the ponds from functioning as ecological traps.
- Lake Chubsucker requires a minimum area for population viability (MAPV) of 100 ha. The current amount of area dredged is 84 ha, which would not support the MAPV of Lake Chubsucker if connections between the ponds and Long Point Bay are not maintained. If further dredging occurs, and the proposed target of 50:50 open water to emergent vegetation in Crown Marsh is reached, the MAPV for Lake Chubsucker will be achieved. The current amount of open water does support the Pugnose Shiner MAPV as it requires 5 ha.
- Population-level parameters for at-risk fishes utilizing the restored ponds were not considered in this study. Future work should be completed on the composition of fishes in channels, movement patterns of fishes, and prevalence of species at risk in piscivore diets. This will help develop a population model as it relates to population trajectories and extinction thresholds to further determine the net benefit of the ponds to species at risk and determine to what extent the ponds facilitate predation mortality. Also, a more refined description of the timing and spatial distribution of spawning and habitat use by YOY and juvenile fishes within the ponds and connecting channels is needed to help refine maintenance and dredging timing windows.
- This report describes studies conducted within ponds in the Crown Marsh in Long Point Bay. Pond creation projects have been undertaken throughout Long Point Bay, both within and outside Crown Marsh. Findings from this study would be applicable to pond creation projects within Long Point Bay, outside the Crown Marsh area.

INTRODUCTION

Crown Marsh, a coastal wetland in Long Point Bay, is part of a wetland complex in the Long Point region of Lake Erie designated as a UNESCO (United Nations Educational, Scientific, and Cultural Organization) Biosphere Reserve due to diverse habitat, flora, and fauna that occupy the region (Thomasen et al. 2013). Crown Marsh is an important feeding and nursery habitat for migrating waterfowl (Meyer et al. 2010) and at least 34 species of fishes utilize wetland ponds in the Long Point marsh complex (Mahon and Balon 1977). Crown Marsh is designated as critical habitat for several fish species at risk including: Pugnose Shiner (*Notropis anogenus*; DFO 2010), Lake Chubsucker (*Erimyzon sucetta*; DFO 2011), and Eastern Sand Darter (*Ammocrypta pellucida*; DFO 2012). Warmouth (*Lepomis gulosus*) and Grass Pickerel (*Esox americanus vermiculatus*) also occur in Crown Marsh (Rook et al. 2016).

The invasive common reed (*Phragmites australis*) is proliferating in the marsh habitat in Lake Erie and Long Point Bay, in particular, causing a reduction in wetland plant diversity (Wilcox et al. 2003) and converting wetland to terrestrial habitat (Schummer et al. 2012). Between 1999 and 2006, common reed had invaded 48 ha of wetland in Crown Marsh, increasing to 157 ha by 2014 (OMNRF, unpublished data). Climate change models for Lake Erie predict a decrease in water level of up to 0.83 m (Mortsch et al. 2006), which will increase the area of Long Point Bay that is susceptible to common reed invasion. *Phragmites australis* is able to colonize areas up to 2 m water-depth, although areas <1 m in depth are preferred (Crisman et al. 2014). The predicted water level decline in Lake Erie would allow common reed to spread throughout the entirety of inner Long Point Bay, substantially impacting the quality and availability of aquatic habitat (McCusker, unpublished data).

To combat the loss of habitat due to the spread of common reed in Crown Marsh, federal, provincial, and municipal governments, along with non-government waterfowl conservation agencies, have mechanically removed common reed and created open-water ponds. It is unknown what the effect of pond creation on populations of fish species at risk will be and whether the constructed ponds would influence habitat use, change population trajectories, or support population recovery.

The purpose of this study is to:

1. Compare and characterize fish assemblages and habitat conditions in constructed wetland habitats and reference sites.
2. Assess the value of the created habitats (sources, sinks) and provide approaches that could be used to maximize this ecological value to at-risk fishes.

This report summarizes the conclusions and advice from the Canadian Science Advisory Secretariat (CSAS) peer-review meeting, held in Burlington, Ontario on May 4, 2016. A research document (Rook et al. 2016) was presented that assessed the effects of habitat restoration on fish species at risk in Crown Marsh. An additional presentation on best management practices for mitigation of dredging projects in Long Point Bay was also conducted. The research document that was reviewed provides in-depth accounts of the summarized information below. Proceedings documenting the discussions and conclusions of the meeting are also available (DFO 2016).

ASSESSMENT

Sampling Procedure

A field study was conducted using a reference-condition approach to determine differences in habitat and fish community in newly constructed and reference ponds in Crown Marsh, Long Point Bay, Lake Erie (Figure 1). The study was conducted on six ponds; four were created by dredging and vegetation removal, and two were minimally disturbed, natural, open-water areas within the marsh. Ponds were generally small (0.33–4.78 ha) and had water depths ranging from 0.15–1.5 m. Each pond was surrounded by cattails and common reed and had a channel connecting the pond to Long Point Bay.

Fishes in each of the ponds were sampled over 3 years (2012–2014) by DFO and OMNRF staff. In 2012, two summer sampling events were conducted and, in the following years, one spring and one summer sampling event were conducted. Ten sites were sampled in each pond by creating an enclosure using a 1.8 x 22.9 m seine (3 mm mesh). Five successive seine hauls were conducted in each enclosure with a minimum 15-minute waiting period between hauls. Fishes were identified to species, counted, and minimum and maximum total length was recorded for each species.

During each sampling event, several water quality characteristics were measured including: water temperature (°C); pH; dissolved oxygen (mg/L); conductivity (µS/cm); and, turbidity (NTU). Additionally, habitat characteristics were assessed at each site including: air temperature (°C); substrate (% by type); aquatic vegetation (% coverage by type); riparian vegetation (% coverage by type); and, water depth (m).

Water temperature and depth were monitored by deploying level loggers (4 m Depth Titanium Water Level Data Loggers, U20-001-04-Ti made by Onset HOBO® Data Logger) after ice out in each of the ponds in the spring of 2012, 2013, and 2014. One logger was set above the water line to record local atmospheric pressure for calibration of water depth. Additionally, level loggers were deployed in the channel connecting the ponds to Long Point Bay in 2013 and

2014. In 2012, loggers placed in both reference ponds were lost, thus, data were only available for the constructed ponds.

Data Analysis

Catch data for each of the five seine hauls per site were pooled and log+1 transformed. Fish assemblage differences among ponds were tested using non-parametric multivariate analysis of variance using the *Adonis* function in the vegan package in R (Oksanen et al. 2010). Principal components analysis using a covariance matrix was used to visualize differences in fish assemblages among ponds.

Differences in habitat variables among ponds were tested using analysis of covariance (ANCOVA) and included submerged vegetation, emergent vegetation, floating vegetation, open water, water temperature, conductivity, dissolved oxygen, and turbidity. When ANCOVA results indicated significant differences, Tukey all-pair comparisons tests were used to identify differences between ponds.

The Wetland Fish Index (WFI; Seilheimer and Chow-Fraser 2006) was used to gauge differences in habitat quality between ponds. WFI scores are correlated with water quality and wetland condition (Seilheimer et al. 2009), with a score below 3.25 generally indicating degraded condition (Cvetkovic and Chow-Fraser 2011).

Results

A total of 1900 seine hauls were conducted throughout the ponds in this survey resulting in the capture of 28,724 fishes from 34 species. Four species at risk (Grass Pickerel, Lake Chubsucker, Pugnose Shiner, Warmouth) were captured during the study. Pugnose Shiner was the most commonly detected species at risk, 70% of which were captured in Reference Pond 1. The ponds acted as nursery habitat for fishes. Juvenile and YOY fishes of 23 species were captured in the study, including the four species at risk whose adults were also detected during sampling events.

Results of the non-parametric analysis of variance indicate that spring assemblages were significantly different among ponds ($p = 0.045$; Figure 2) but not different among years ($p = 0.22$). The reference ponds had a greater abundance of Blackchin Shiner (*Notropis heterodon*) and Pugnose Shiner than the constructed Ankney Pond, Kozac Pond, and Thompson Pond.

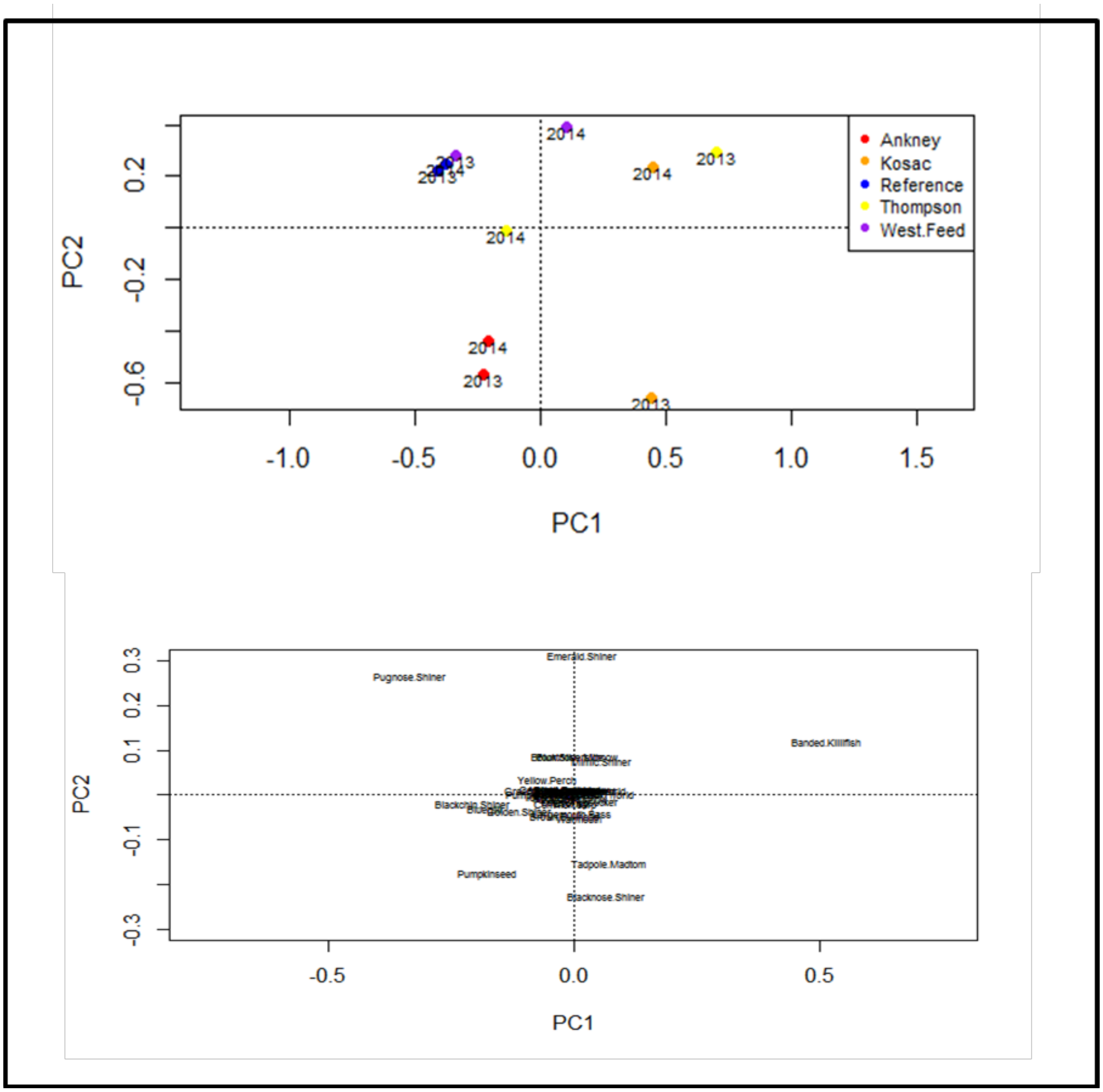

Figure 1. Ordination plot comparing fish assemblages in each pond, spring 2013–2014, based on species abundance data. Note that there is a difference in scales between the site and species plots. There was a significant difference in assemblage composition among ponds (p=0.049), but not among years (p=0.221).

When summer fish assemblages were compared, each pond had a significantly different assemblage from the others ($p = 0.05$) and assemblages differed among years ($p = 0.001$). The assemblages found in all of the constructed ponds differed in composition from those in the reference ponds (Figure 3).

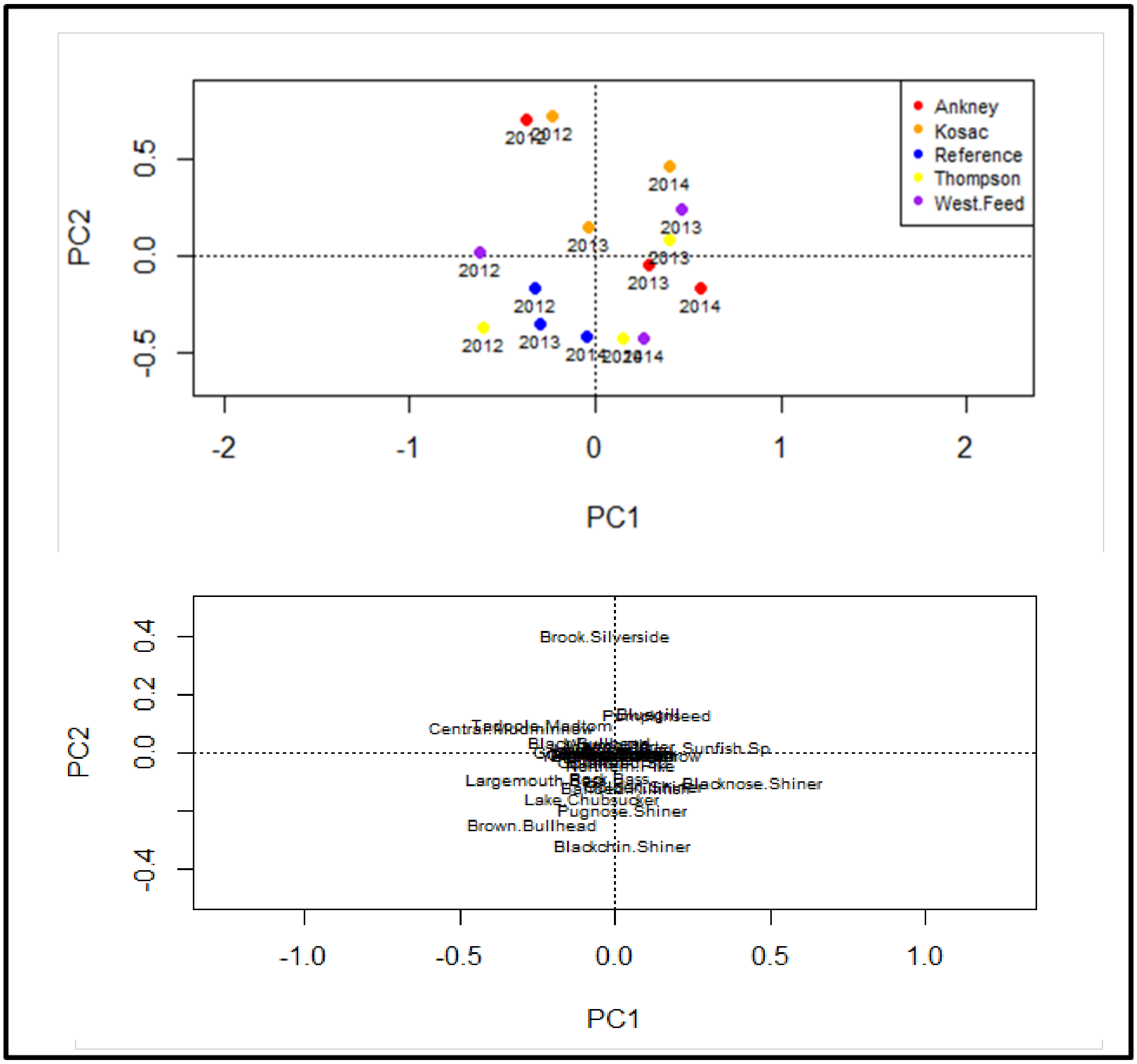

Figure 2. Ordination plot comparing fish assemblages in each pond, summer 2012–2014, based on species abundance data. Note that there is a difference in scales between the site and species plots. There was a significant difference in assemblage composition among ponds (p=0.05) and years (p=0.001).

Vegetation coverage remained relatively stable through time over the course of the study but differences among ponds were observed. The newly constructed Ankney and Kozac ponds had significantly less submerged vegetation coverage than Reference Pond 1 ($p < 0.001$) in the summer but no difference was observed between these newly constructed ponds and Reference Pond 2. Submerged vegetation was the dominant type of vegetation found in all ponds and vegetation coverage was higher in summer than in the spring in all ponds.

Water-quality parameters were significantly different in the spring among ponds (Table 1) and between years, and in the summer, parameters differed among ponds (Table 2) but not between years. The newly constructed ponds were more turbid than the reference ponds and two had low dissolved oxygen levels during summer sampling. The newly constructed ponds were also shallower than the reference ponds, leaving them more susceptible to warming in the summer, lowering of dissolved oxygen levels, and freezing to the bottom in the winter.

Table 1. Among-pond comparisons of spring mean water quality measurements and pond depth, based on 2012–2014 data. Cond. = conductivity, DO = dissolved oxygen; Temp. = temperature.

Site	Water temp. (°C)	Turbidity (NTU)	Cond. (µS/cm)	DO (mg/L)	Depth (m)
Ankney Pond	22.15	32	383.55	6.42	0.39
Kozac Pond	21.8	28.15	307.25	9.25	0.33
Thompson Pond	20.63	9.36	389.1	9.13	0.37
West Feed Pond	17.82	16.53	335.5	7.34	0.59
Reference Pond 1	21.5	8.32	350.4	6.51	0.78
Reference Pond 2	20.19	22.98	373.45	5.61	0.6

Table 2. Among-pond comparisons of summer mean water quality measurements and pond depth, based on 2012–2014 data. Cond. = conductivity, DO = dissolved oxygen; Temp. = temperature.

Site	Water temp. (°C)	Turbidity (NTU)	Cond. (µS/cm)	DO (mg/L)	Depth (m)
Ankney Pond	24.36	14.01	355.55	7.39	0.46
Kozac Pond	24.18	6.67	363.85	6.52	0.21
Thompson Pond	20.99	6.67	349.05	7.8	0.46
West Feed Pond	22.95	13.37	345.8	8.31	0.35
Reference Pond 1	23.34	10.05	292.7	7.75	1.05
Reference Pond 2	24.56	2.28	386.8	6.48	0.85

Based on the WFI, all of the ponds were in a healthy condition throughout the course of the study (WFI > 3.25). Habitat quality improved over the course of the study (Table 3) and Ankney pond and Reference Pond 1 had the highest mean habitat quality among the sites.

Table 3. Wetland fish index (WFI) values for each pond over the six sampling events. A value below 3.25 generally indicates degraded wetland habitat condition.

Site	July 2012	August 2012	Spring 2013	Summer 2013	Spring 2014	Summer 2014
Ankney Pond	3.69	4.02	3.91	4.08	3.99	4.07
Kozac Pond	3.56	3.67	4.14	3.71	3.94	3.72
Thompson Pond	3.63	3.98	4.01	3.8	3.84	3.95
West Feed Pond	3.58	3.62	3.78	3.66	4.02	3.88
Reference Pond 1	3.96	4.04	4.13	4.15	4.21	4.06
Reference Pond 2	3.63	3.8	4.06	3.29	3.94	3.86

Sources of Uncertainty

The sampling conducted provided information on the habitat and fish assemblages in the constructed and reference ponds within Long Point Bay. The main source of uncertainty, however, is whether these ponds act as population sinks. Population-level parameters were not measured in this study so direct inferences could not be made on the effect of pond creation on the production of species at risk fishes.

To understand the spatial dynamics of species at risk populations within Crown Marsh, several areas of future research have been identified:

1. Assessing the composition of fish assemblages within navigation channels to understand whether they act as source populations for newly constructed ponds;
2. Quantifying the movement patterns of fishes across life stages among different habitats within Crown Marsh, and between other inner Long Point Bay habitats and Crown Marsh;

3. Assessing the use of constructed ponds as suitable over-wintering habitats, including likelihood of ice formation to the bottom of ponds and sufficiency of dissolved oxygen levels;
4. Examining the variation in prevalence of fish species at risk in piscivore diets among habitats; and,
5. Measuring the abundance of larval and juvenile fishes to gauge spawning success.

CONCLUSIONS AND ADVICE

The constructed ponds in this study were occupied by 34 fish species, including four species at risk (Grass Pickerel, Lake Chubsucker, Pugnose Shiner, and Warmouth). As a result of pond creation, the amount of open-water habitat in Crown Marsh increased from 37.52 ha in 2006 to 84 ha in 2014. This amount of available habitat is larger than the area required to sustain the minimum viable population (MVP) size for Pugnose Shiner (DFO 2010). If the target of 50% open water within Crown Marsh is reached through the creation of additional ponds, the amount of habitat required to support an MVP for Lake Chubsucker will also be met (DFO 2011), assuming connectivity between pond populations. Juvenile and YOY fishes of 23 species were also detected in the ponds, indicating that the ponds were utilized for spawning and rearing habitats. Creating and maintaining multiple connections of the ponds to Long Point Bay, and each other, is important to ensure that fishes can migrate to the ponds for spawning and to allow for fishes to exit the ponds if conditions become unfavourable. Creation of a depth gradient in new ponds, with the deepest area at the connecting channels, would help to reduce stranding of fishes in times of low water levels.

The habitat that was created is of a healthy quality, based on the WFI, although the newly constructed ponds had less submerged aquatic vegetation than reference ponds. This lack of vegetation may make small-bodied species at risk (such as Pugnose Shiner) vulnerable to predation. Lack of vegetation may be minimized by refraining from extensive maintenance works. Monitoring the rate of vegetation recovery in the constructed ponds should be undertaken and, if recolonization of vegetation remains limited, the appropriateness of transferring a native seed bank from other proximal locations should be evaluated.

This report describes studies conducted within ponds in the Crown Marsh in Long Point Bay. Pond-creation projects have been undertaken throughout Long Point Bay, both within Crown Marsh and in other areas. The conclusions and advice regarding the creation of pond habitat within Crown Marsh should be applicable to other pond-creation projects within Long Point Bay, as well as those in Crown Marsh.

SOURCES OF INFORMATION

This Science Advisory Report is from the May 4, 2016 Evaluation of habitat restoration activities for species at risk fishes within the Crown Marsh (Long Point Bay). Additional publications from this meeting will be posted on the DFO Science Advisory Schedule as they become available.

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